Abstract

Municipal solid waste (MSW) production has significantly increased in the rapidly urbanizing developing world and also changed composition with increased decomposable organic fraction in MSW (OFMSW) and plastics content. This has stressed the environment in many ways while city managers and citizens have responded with various technological and management solutions leading to a need for scientific, environmental, technological and sustainability assessments of the emerging problems. This sets the research agenda and framework for this study wherein the MSW generation, composition, processing and treatment methods, open dumping practices, environmental liability, natural degradation, sustainability issues etc. have been studied for the city of Bangalore as a model for such an emerging problem. Results show that MSW generation ranged from 0.1-0.4 kg/person/day and the OFMSW content was >80% emerging predominantly from fruit, vegetable and food wastes. About 10-15% of daily MSW generated appeared to be haphazardly dumped around the city in ~700 small to large dumps ranging from 10-6,500 m^2 with potential for large GHG emissions. Their spread and characteristics were assessed for 3 consecutive years using a novel rapid survey method developed at IISc involving motorcycle borne student volunteer teams, GPS enabled locating, physical measurements and satellite image interpretations. Results indicated that dump sites were of three types, ephemeral small sized in the core area (303) functioning as transfer stations, medium sized ones in outer areas that were closed rapidly with construction debris and very soon inhabited with dwellings and the larger and longer duration dumps (2-3 years, 393) in the peripheral regions within 10 km from the city administrative boundary. This method was compared with physical measurement and satellite imaging and gave very high level of accuracy and is hence suggested for other cities as well. A smaller fraction of MSW is also dumped in open drains that lead to choking and flooding of 3 locations and this was studied with some detail. The environmental footprint of such dumps were assessed by theoretical and experimental on-site and off-site approaches and experimental results show low GHG (CH_4) emissions and emission factors that was largely attributable to the shallow depth of dumps (~0.7 m) and its low pH. The decomposition rates were experimentally determined for open dump sites and drivers for decomposition monitored. By providing differential access to macro-fauna, meso-micro organisms and only soil contact in field scale experiments it was determined that the greatest loss in weight occurred primarily due to the rapid drying process that brings down decomposition within 6 days. During the early stages of decomposition, mostly micro with meso organisms are responsible and after 6 days, the moisture

content falls below 60% making microbiological decomposition difficult and enabling other foraging organisms to take over. The weight loss (decay) could be patterned both on exponential decay or a two component fit representing a rapid initial decay followed by a slower long term decay process similar to soil application of organic matter. Monitoring the decentralized MSWM practices in the city suggests that small scale composting and biomethanation is gaining acceptance and is the possible direction for OFMSW in growing cities.